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BATTERIES *VERSUS* MAGNETO-ELECTRIC CURRENT MACHINES.

THE relative values of batteries and magneto-electric current machines for telegraphic and manufacturing purposes is a question which has excited considerable difference of opinion in the electrical world.

The word "battery," although it does not convey a definite idea to the unscientific mind, nevertheless is well understood by electricians and telegraphists to signify an arrangement for generating electricity by means of chemical action, whilst the expression "magneto-electric machine" is understood to represent the idea of an apparatus for generating electricity by mechanical force.

As regards the telegraph system, so long as the employment of the telegraph was limited, and the number of instruments in an office was consequently also limited, the annual cost of maintenance of batteries formed but a comparatively small item in the general working expenses of the establishment; but, at the present time, when the number of instruments at head offices may be numbered almost by hundreds, the substitution of mechanical for chemical power becomes a question which may not be passed over without consideration.

The question, when carefully considered, resolves itself into one of £ *s. d.* Can electricity, for working telegraph instruments, be produced the more economically by batteries, or by magneto machines? To answer this query, several points must be considered. Setting aside the employment of magneto machines at small offices, we will confine our attention to their use at large offices, where some hundreds of battery cells are employed.

To work a number of instruments properly, we must have the means of varying the electric power according to the requirements of each circuit, the shorter circuits requiring obviously less power than the longer ones; climatic considerations may alter conditions, and we may require to add power to the circuits should their insulation fall low.

In order to adjust the current for various circuits we must either have a particular machine for each circuit, or a machine for a set of circuits whose working capacity would be about the same, or, lastly, one large machine to work the whole number of circuits, with an arrangement of resistances to equalise the power, so that the short circuits may not draw off too much of the current from those of a longer length.

Now, to employ a machine for each circuit would involve a heavy expense, as regards prime cost compared with the cost of batteries. Supposing an engine was employed to drive them all, this means expensive shafting and driving bands; and, again, this must be so arranged that the speed of any particular machine can be increased should the power for the circuit to which it is attached be required to be increased. If the machines be adapted to sets of circuits, a fault giving earth on one circuit would be sufficient to stop all the others. This objection would hold still more if one machine were employed to work all the circuits. The possibility of a break-down of a machine where one or only a few were used would be a very serious matter, as it would mean the stoppage of a large number of circuits. When a battery is employed for each instrument the chances of stoppages of several circuits are very small, and these can always be provided against by spare batteries, which can be applied to any particular circuit which may require them.

With reference to the application of electric power to manufacturing purposes, such as electro-plating, the purification of sugar, the electric light, the transmission of power to a distance, &c., where a very strong and steady current is required to work through a low resistance, there can be but little doubt but that magneto machines have an overwhelming advantage over batteries (as at present constructed), but this advantage may, at some future day, go the other way, as it seems likely that an enormous source of electric power may be found in the waste chemical products which are at present so difficult to get rid of.

AN ELECTRICAL ARRANGEMENT, ENABLING THE RECEIVING STATION TO INTERRUPT THE SENDING STATION ON DOUBLE-CURRENT INSTRUMENTS.

By C. CHR. SONNE, Great Northern Telegraph Co.

THE diagram will show the arrangement.

Between the transmitter T and the galvanoscope G is inserted a switch S with two plugs, A and B. Both plugs being inserted, the current from the transmitter will be divided there, one part going into the line, another part through the bell C and resistance

coils R to earth. This branch circuit is so regulated that its resistance is considerably (five to ten times) higher than the resistance of the line and the instruments of the receiving station, but at the same time considerably lower than the resistance of the line when insulated at B (the receiving station).

Thus a comparatively small part of the current will pass through C and R without any effect on the bell, and without weakening the current arriving at the receiving station to any material extent.

Now if B wishes to interrupt A in sending a batch of messages—for "paper," or any other reason—he will remove the plug *a* for a moment, thereby insulating the line and causing the greater part of the current to flow through the branch circuit at A, this circuit now offering less resistance to the current from A's transmitter than the insulated line. The increased current will then make the bell C ring, and the clerk will at once stop his transmitter. The operator at B will, after a moment's insulation, reinsert his plug, when he will see at once that A has ceased sending and is waiting for what he may have to communicate.

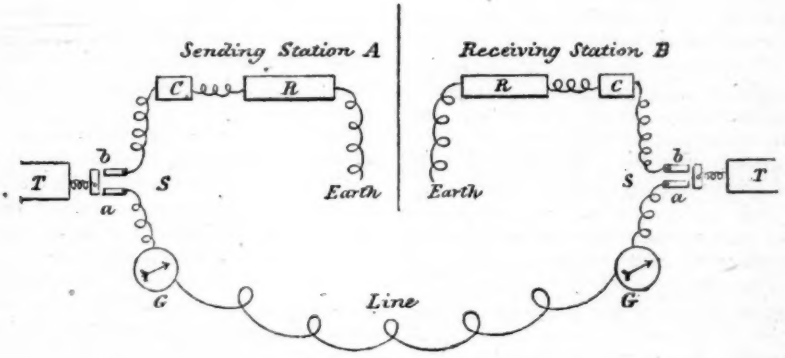
On the receiving station there will be a very slight loss of current through the branch circuit, but this loss may be made away with if necessary by removing plug *b* while receiving.

In using this arrangement the following points must be observed:—

The resistance R must be chosen as high as possible, to prevent more loss of current than can be helped; on the other hand, it must not be so high that the part of the current that passes it when the line is insulated is unable to ring the bell. It will thus be seen that the larger the difference between the resistance of the conductor and the dielectric, the wider margin there is for the adjustment of R, so that small alterations in these resistances will not necessitate any alteration in R.

With one of Wheatstone's sensitive double-current bells nicely adjusted, and a battery of about 20 Leclanché cells, R may be made as high as 25,000 ohms.

As I should be glad to hear of this arrangement being of use to anybody, the Editor of the *Telegraphic Journal* has kindly consented to receive any communications about it, and forward them to me.



PHELPS'S ELECTRO-MOTOR PRINTING TELEGRAPH.*

(*Continued from page* 91.)

THE electro-magnets R R, &c., eight in number, are arranged in a circle within a cylindrical case R_1. The magnets are of the ordinary form, having cores 0·5 inches diameter, and 1·25 inches in length, wound with insulated copper wire 0·042 inches diameter. Five soft iron armatures *r r*, &c., are arranged at equal distances around the periphery of a hub r_1 of brass upon a vertical shaft Q, supported at its lower end in an adjustable step or bearing Q_1 and at its upper end in a top plate Q_2. The motor battery is connected by the screw s^1 to the insulated lever S, which is mounted upon a spring *s*, and pressed downward by the action of the screw s^1, acting upon a flat spring s_2. The screw s^1 serves to regulate the speed of the machine in the manner about to be explained: W is a thick piece of metal mounted upon the main shaft Q of the motor, and serves as a counterbalance or fly-wheel. A section of this, W_1, is mounted upon a spring *w*, and has an arm, w_1, attached to it. The rapid revolution of the shaft Q when the motor is in motion tends to throw the section W_1 (which acts as a weight) outwards by centrifugal force. When this takes place the arm w_1 is raised, then the pin w_2 (which passes through the upper part of the shaft Q, the latter being hollow) is forced upwards, and by means of the cup w_3 and insulated pin s_2 raises the lever S by bending the spring s_3. V is a platinum-faced wheel or disc, which revolves slowly by means of a worm acting upon a toothed wheel fixed upon its axis, not shown in the figure. The wheel V revolves in a cup V_1 partially filled with oil. The platinum edge of the wheel V and the platinum stud s_4 on the lever S are in contact at all times, except when the speed of revolution exceeds the rate to which the machine is adjusted by the screw s_1. The constant motion of the wheel V keeps the contact surfaces clean, and there is but little friction on account

* From Prescott's "Electricity and the Electric Telegraph." London: Spon & Co., Charing Cross.

of the oil. When the speed of the machine becomes too great, the weight W_1, being thrown out by the centrifugal force as its supporting spring w bends, raises the inner end of the arm w_1, which lifts the lever S by means of the rod w_2, breaking the contact between s_3 and V, and, by thus diminishing the battery force, at once lessens the speed of the motor. The current from the motor battery, passing through the lever S, wheel V, and frame of the machine to the commutator next described, is directed through the several electro-magnets in succession, and finally finds its way back to the battery by a common battery wire connected to the insulated metallic ring Q_3. The number of contact springs in the commutator is equal to the number of electro-magnets multiplied by the number of armatures, viz., forty. Each separate electro-magnet is charged each time it is approached by either of the five armatures during their revolution. This is effected by connecting each of the magnets R R, &c., with one of eight flat metallic segments, X (which are insulated from each other, and placed close together within the frame of the machine), by means of insulated rods, x_2, to which the magnet wires are fastened. Five of the forty commutator springs $x\,x\,x$, &c., are connected to each of the conducting segments X X by means of studs x_1, passing through the frame and insulated therefrom, each fifth spring being connected by means of its corresponding stud to the same conducting segment. The frame or case R_1 of the motor has a circular opening in its top plate, within which opening the contact wheel Y runs. This wheel Y is mounted at the end of a link Y_1, which is hinged to a projection from the main shaft Q, and is constantly pressed against the inner edge of the opening in the frame by a spring y_1, so that the frictional contact is always sufficient to turn the contact wheel. The periphery of the latter is grooved as shown at y, and runs upon the edge of the opening, as upon a railway track. The contact wheel Y also runs in contact with the ends of the commutator springs $x\,x$, which yield sufficiently to bring each successive one into contact with the wheel before the preceding one is out of contact. The portion of the periphery of the wheel Y, which runs in contact with the springs, is of larger diameter than that which runs upon the frame, as will be seen by referring to the figure. The object of this arrangement is to cause the surface of the wheel Y to slide or rub upon the springs $x\,x$ as it revolves, and thus keep the surfaces clean without unnecessary wear.

It will, of course, be understood that the wheel Y forms an electrical connection between the frame and the successive commutator springs as it revolves, and thus charges the electro-magnets in rotation, each magnet being charged five times during one revolution of the main shaft Q, by which means each armature is attracted and released at the proper moment.

In order to avoid the spark which would otherwise be produced at each breaking of the contact between the stud s_3 and the platinum-faced contact wheel V, a permanent connection is made between the screw s_1 and the frame of the machine by means of a resistance coil Z, which, when the contact between s_3 and V is interrupted, conveys a sufficient quantity of current from the battery to the motor to cause the latter to revolve, but at a rate of speed considerably less than the normal rate to which the machine is adjusted. The effect of breaking and closing the contact between s_3 and V is therefore merely to increase and diminish the total resistance of the circuit by an amount equal to the value of the resistance Z, and the extra or induced current, having a path through the coil Z, occasions but an inappreciable spark upon the contact wheel V.

The revolution of the motor is communicated to the instrument by means of a pinion Q_4, which gears into a wheel Q_5, of about four times the number of teeth, and this in turn is geared directly to the hollow wheel E upon the shaft C of the transmitting machinery (figs. 2 and 3).

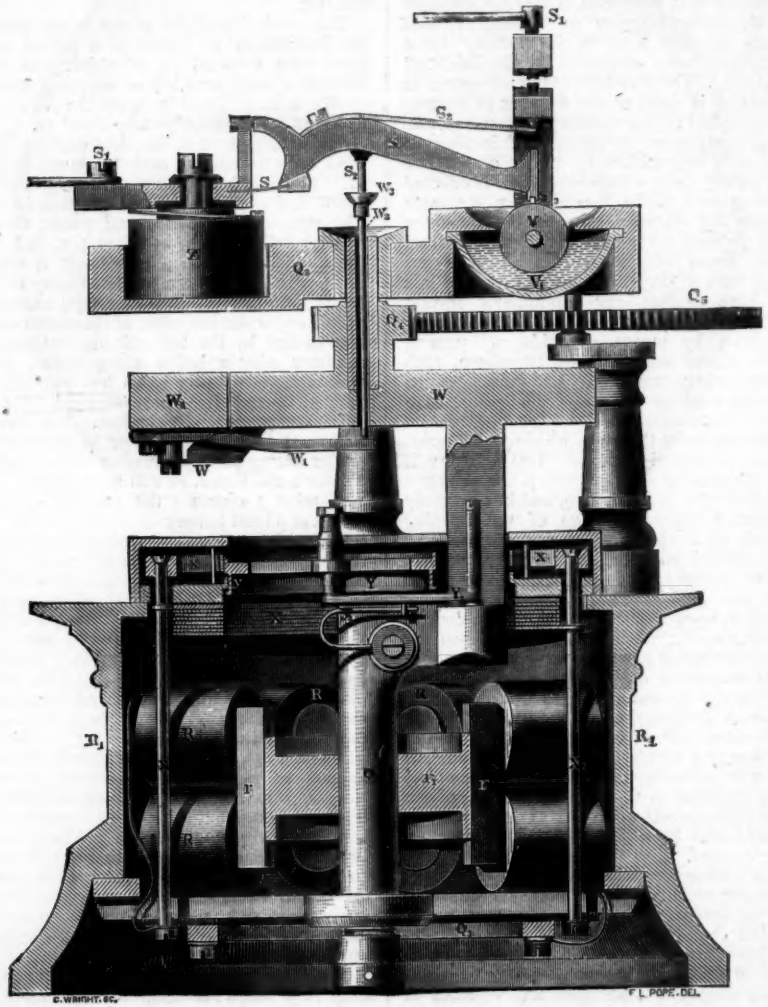
The arrangement of the main and local circuits of the Phelps instrument is shown in the diagram, fig. 12. The switch is placed at the right of the keyboard, and is represented in position for receiving. The current enters at 1 and passes through the relays 2 and 3, thence by wires 4, 5, and 6 through the switch, and thence by wires 7, 8, and 9 to the earth. The relay 3 is a polarised relay of Siemens's or other suitable construction, and closes its local circuit under the influence of the positive pulsations sent to line by the transmitting instrument. The auxiliary relay 2 has a non-polarised or neutral armature, and is very much less sensitive than the relay 3, so that it is not affected by the ordinary pulsations passing over the line. The object of this relay is to enable the receiver to break or stop the sender during the transmission of a despatch, or to answer a call signal, as will be hereafter explained. The relay 3 operates the printing magnet M by means of a local battery of six small cells. If the receiver wishes to stop the sender, he turns his switch to the position marked "break," which throws his own main battery into the line circuit, by way of 5, H_1 h_2 10, 11, switch lever 15, h_1 H_2 and 8. The effect of this is to double the strength of the pulsations passing through the relay 2, and cause it to actuate a small sounder placed in a branch circuit from the common local battery. This effect takes place upon both the sending and receiving instruments, and the sending operator is thus notified of the interruption by the working of the sounder. The break 13 opens the local circuit of the printing magnet M, whenever the switch is turned to "break," and thus prevents the printing mechanism from operating, and introducing superfluous characters into the printed record. When sending, the switch is turned to the point marked "send," the connections being precisely the same as when turned to "break," except that the local circuit of the printing magnet now remains intact, and the printing mechanism may be stopped, if desired, by pushing in the stop O_1 in fig. 7.

The manipulation of this instrument is theoretically very simple, although it will be obvious that a vast amount of practice is required on the part of an operator before he can expect to be able to finger the keyboard with the skill and rapidity which is necessary in order to develop the full capacity of the instrument, which exceeds even that of the combination. For example, an actual trial was made, an operator sending continuously for five consecutive minutes, the matter being an ordinary newspaper despatch from Washington, selected

at random. The number of words transmitted during this length of time was 290, containing 1,634 characters, inclusive of letters, points, and spaces, or 58 words per minute—a rate of speed which some of the more skilful operators can maintain for a long time. By a careful analysis of the above despatch it was found that the alphabetical sequence

The operator, before commencing to transmit a despatch, sets his motor in motion by closing the circuit of the motor battery by means of a button switch at the left of the keyboard. He then turns his switch to "send," and depresses a certain predetermined series of keys, the pulsations from which operate the relay and printing magnets of each

FIG. 11.



of the letters was such that an average of two characters could be printed from during each revolution. Therefore, by depressing two keys and permitting the instrument to revolve at the normal rate, its actual capacity was easily ascertained by counting the number of revolutions per minute. This was found to be 166—332 letters, or 59·3 words per minute.

instrument with a distinctly audible sound, serving as an alarm. The receiving operator signifies his readiness to proceed by changing the position of his switch from "send" to "break" for a moment, which causes the sending operator's pulsations to manifest themselves upon his own sounder. The sender then depresses his blank or dash key, transmitting the pulsations in groups of three, with an

Fig. 10.

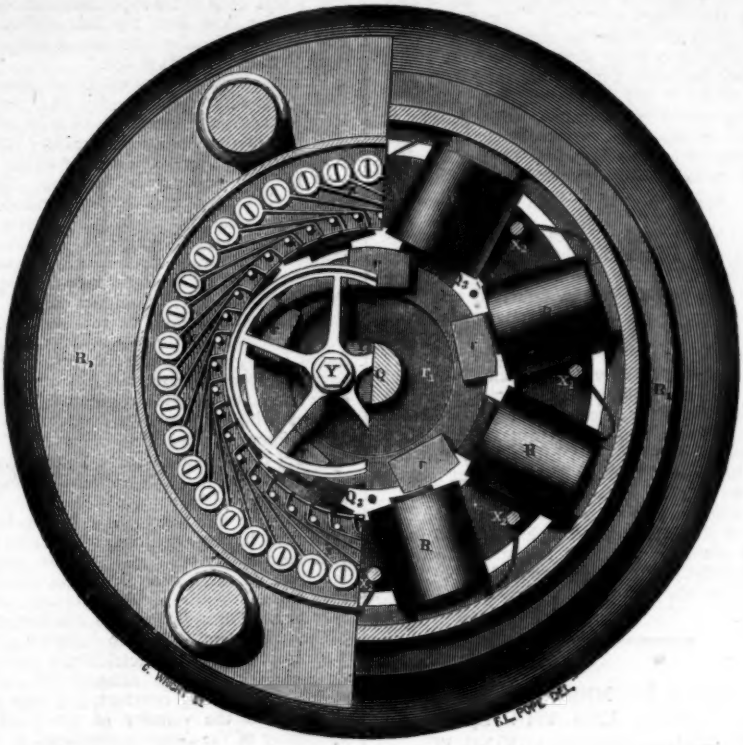
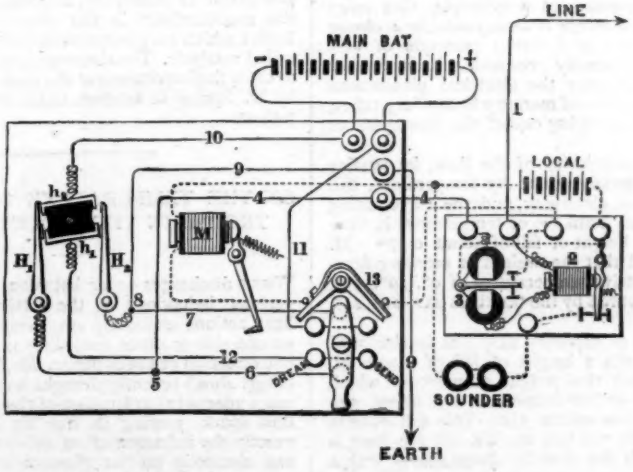


Fig. 12.



interval between each group, so that the receiver may adjust the speed of his motor. When the latter has accomplished this he signals the sender by turning the switch to "break" for a moment. The sender then allows the instrument to make a few revolutions, so as to bring the automatic unison of the receiving instrument into action, and then proceeds to transmit his communication, letter by letter, being careful to commence with the dash or blank key. In case the two instruments get out of correspondence, which seldom happens unless the line is in bad order, the receiver can stop the sender at any time by turning the switch to "break."

The local battery which drives the motor consists of two large Bunsen cells, charged with Poggendorff's bichromate solution in contact with the carbons in the porous cell, and diluted sulphuric acid in the outer or zinc cell. The containing jars are of glass, 9 inches in diameter and 6 inches high. The zinc cylinders are 8 inches outside diameter and 0·5 inches thick, within which is placed a porous cell 7·5 inches diameter. The carbon element consists of two rectangular plates, placed parallel and about two inches apart, each plate being 5 by 6·5 inches. This battery will run the motor continuously for fifteen hours without requiring a renewal of the bichromate solution.

It has not been found necessary to adapt any repeater to this system, as it has proved itself capable of working direct at full speed between New York and Chicago, a distance of 1,000 miles by the route of the line.

ON THE FLOW OF MERCURY BY CAPILLARY TUBES, AND THE ELECTRIC PHENOMENA ACCOMPANYING IT.

IN a former communication to the Belgian Academy* M. Spring enumerated, as a principle, that *every change in attractive energy is accompanied by a change in the electric state of bodies*—a principle of vast application, if generally verified. In a further memoir he investigates the electrical phenomena accompanying the flow of mercury in capillary tubes, with the view of verifying one of the consequences of this principle.

Considering the velocity of the flow, he studies the influence exercised on it by temperature, the capillary meniscus, electricity, and the surrounding atmosphere. The influence of temperature is very sensible, with a height of fall of about 0·37m. M. Spring has found that the weight of mercury flowing at the successive temperatures of 0°, 20°, 55°, 85°, were represented by the numbers 212, 228, 248, 261.

The influence of capillary meniscus is also well marked: thus, with a height of fall of 0,29m. M. Spring found that the weight of mercury which flowed with the orifice immersed was about 342 grammes, with free orifice 334. This influence is more considerable the less the fall, till the limit is reached at which the flow by drops ceases with a height of fall 0·45m. M. Spring thinks the formation of the drops has no influence on the velocity of flow; still, each of his experiments shows a diminution in the flow from the free orifice. M. Spring finds further that the influence of temperature adds itself to that of height of fall.

Coming now to the electrical phenomena, M. Spring demonstrates directly the production of electricity through formation of drops of mercury in the flow of the liquid from capillary tubes, and he proves that this production is not in the least due to friction of the mercury in the tube. This quantity of free electricity produced is of course very small, and only rendered sensible by apparatus of extreme delicacy, the idea of which was borrowed from M. Zöllner. M. Spring was not able to assure himself experimentally that the mercury drops are heated—the quantities of heat being so small. But he has shown that an electric current traversing the mercury column from the exterior to the interior produces a very considerable increase and the inverse current a decrease in the quantity of mercury flowing out; and he was careful to eliminate all the secondary actions whose intervention was to be suspected. This influence exercised by electricity on the flow of mercury drop by drop leads him to conclude that the formation of the drops must be the cause of a production of electricity.

Lastly, he has observed that it is in dry atmosphere not having any chemical action on the mercury that the velocity of flow is greatest, and that there is a sensible retardation if the atmosphere is moist, or if it is of a nature to be capable of combining with mercury. According to him, the heating produced by neutralisation of the two electricities in the mercury drop, when these electricities have not to produce decomposition in the atmospheric medium, diminishes the capillary constant, and thus produces an increase in the velocity of flow; while, if the electricity of the drops is employed to separate the constituent elements of the surrounding atmosphere, this heating no longer exists, and there results a diminution in the velocity of flow. Perhaps to this production of electricity, he adds, may be attributed the modifications in the state of aggregation of bodies which may be connected with the phenomena called catalytic. The above analysis will be sufficient to show the importance of the phenomena discovered by M. Spring in relation to the study of molecular actions.

* *Telegraphic Journal*, Vol. VI, p. 341.

ON THE TEMPERATURE OF THE ELECTRODES IN THE INDUCTION SPARK.

WHEN discharges occur between electrodes, a very various behaviour of the latter is noticed, and heat actions especially are found to preponderate on one side or other, according as the discharge is in one direction or the opposite. Mr. Hermann Herwig (*Pogg. Ann.*) recently thought he might arrive at a more adequate explanation of the case of the induction spark passing in free air if he determined exactly the influence of an independent heating of one electrode on the phenomena. Such heating, by supplying beforehand a certain portion of that heat which otherwise the discharge must effect, seems

specially fitted to throw light on the nature of the relations in question.

In carrying out this plan, the ends of the secondary coil of a large Stöhrer induction apparatus were connected through a sensitive mirror galvanometer, and then brought in a symmetrical manner to the two halves of a severed platinum wire, which were placed horizontally one over the other, and crossing at right angles, being separated by a small layer of air. The free ends of the platinum wires passed over insulated pulleys, and were stretched with weights, while the other ends were connected with the induction wires through a commutator, by means of which the upper wire could be made the positive or negative electrode for the induction currents always going in the same direction. The upper platinum wire could then, by means of mercury cups, and without any disturbance, be inserted in the circuit of a special battery, by means of which it could be heated to the commencement of a weak red glow. The direction of the current used for heating was indifferent for the results of the experiment.

With these arrangements, the effect on the galvanometer of a single making and breaking current was each time observed; first, when both the wires were cold; and next, when either the positive or the negative wire was heated. It is evident that the galvanometer-effect with such induction sparks is also dependent on other circumstances; as on the softness of the electrodes, which in later discharges is greater than in earlier. Hence, a definite explanation could only be expected from numerous suitably arranged experiments; and the mode of proceeding was, that, in connected series, ten experiments were made with cold wires, then ten with glowing of the positive, ten with glowing of the negative, again ten with cold wires, ten with negative glowing, ten with positive glowing, and lastly ten with cold wires. With cold wires, the upper was alternately positive and negative. The average values obtained from several hundred experiments are contained in the following table :—

Separation of the wires.	Deflection.		
	With cold wires.	With positive heated.	With negative heated.
¼ mm.	126·5	261	337
½ „	55·5	122·5	201·5
¾ „	40	55·5	175
1½ „	5	19	82
4 „	4	15	30

"Without attaching too great value to the numbers," says Mr. Herwig, "it may thus be affirmed with certainty that a vigorous heating of the one electrode lets greater quantities of electricity from the action of certain electro-motive force of induction pass over, and that this holds pre-eminently for the negative electrode. The first part of this result might have been expected, as both the tearing loose of metallic particles and the driving of charged air particles out from an electrode already highly heated must take place more easily; it also distinctly shows that both electrodes essentially participate in the discharge. Of much greater importance, however, is the second part, according to which the negative electrode, under the same favouring influence, gives much more abundant quantities of electricity than the positive. Further, the above-mentioned variability attaching to galvanometer actions in such experiments mostly ceases when the negative electrode glows, and secondly it is only in the case of the glowing of the negative electrode, with short distances, that a slight galvanometer action is also sometimes obtained with the closing induction current.

"Thus, what earlier experiments made probable enough, is undoubtedly confirmed (it seems to me) by these experiments, in a more direct manner, that, namely, even in the induction spark, which passes in free air, *the negative electricity is more easily put in motion*. For the gas discharges of the Holtz machine, this has been likewise proved by MM. Wiedemann and Rühlmann."

With the assumption, now no longer arbitrary, that in the separation of charged metal or gas particles from the electrodes the negative charge is more easily carried away, M. Herwig points out that the insufficiently explained one-sided action of such discharges becomes readily intelligible. In general, apart from various conditions modifying the phenomenon, experience teaches that the negative electrode shows the greatest production of heat, when a discharge occurs discontinuously with short impulses; when, on the other hand, the discharge is of a more regular, continuous character, the heat action preponderates at the positive electrode. Now the heat action is chiefly at the place where the electric motion is terminated, or where the electric equalisations specially occur. With the discontinuous discharge the greater mobility of the negative electricity acts so that a stronger backward equalisation of the electricity takes place at this electrode, and, besides, the equalisation must also occur in the portion of air in the neighbourhood of the negative electrode, because, according to Wiedemann and Rühlmann's observations, the more difficultly discharged positive electricity is driven forth with greater velocity from its electrode.

With the more continuous discharge of the Voltaic arc, on the other hand, the interrupting layer may be regarded as pretty conducting, so that the greatest heat effect occurs in the place of the greatest resistance, that is, in this case, at the positive electrode.

Notes.

THE Direct United States Cable Company have given notice that, on and after May 1, the charge for the transmission of messages by the company's cables between the United Kingdom and New York, Canada, &c., will be three shillings per word. Rates to other places, and further particulars, will be issued in due course.

A SYSTEM of regulating clocks by pneumatic action has been tried with success in Vienna. The inventor

is the Austrian engineer and electrician, M. Mayhofer.

THE Friday evening lecture on the 13th inst. at the Royal Institution was given by Mr. William Spottiswoode, LL.D., the subject being, "Experiments with a great Induction Coil." The value of the instrument in showing stratified discharges of electricity through vacuum tubes was shown by numerous and beautiful experiments.

WE have lately had the opportunity of inspecting a system of Pneumatic Despatch Tubes which has been fitted up in the Inns of Court Hotel, Holborn, by Mr. Zimdars. The power for working the tubes is obtained by means of a small donkey engine, which can be worked either by hand or steam. Two tubes communicate with the upper part of the building. An ingenious air-dividing apparatus enables a certain pressure to be obtained in one tube and a vacuum in the other. By means of a reversing air-cock the pressure or vacuum can be directed into either tube at will. The whole arrangement is admirably designed for the purpose for which it is intended—viz., for the transmission of messages from one part of the hotel to the other. We congratulate Mr. Zimdars for the successful way in which he has carried out the whole work.

THE new Fire Alarm Telegraph for Baltimore, U.S., will have 175 miles of line and 250 alarm boxes. It is believed that it will be the most perfect system in existence.

PROF. A. GRAHAM BELL has made some very interesting experiments with his telephone at New York. Conversation was carried on between that city and Boston to the wonder and delight of the visitors present. Prof. Bell has received from the judges of the late International Exhibition at Philadelphia an award for his electric telephone and multiple telegraph. The report of this award, which was written by Sir William Thomson, and approved by his associate judges, says of Mr. Bell's invention that the apparatus includes an ingenious and effective instrument for automatically making and breaking an electric contact every time one of his telegraphic musical notes commences and ceases to sound. Thus his multiple telegraph may be made self-recording (after the Morse or Bain method), or may be worked forward by relays through greater lengths of line than imperfectness of the insulation allows to be worked in one circuit. The report speaks of this invention as having many practical advantages over other methods of multiple telegraphy, and is very complimentary throughout to Mr. Bell for his solution of a difficult problem. Now that we have had a practical demonstration of what Elisha Gray's telephone is capable of, why does not Prof. Bell introduce his system to a metropolitan audience?—*The Operator*.

AT the meeting of the Society of Telegraph Engineers, to be held on May 5, a paper will be read by M. Rische on "Double-Current Translators."

WE noticed, a short time ago, the important invention of MM. Jabloschkoff and Denayrouze for obtaining a steady electric light without use of a regulator, the arrangement being somewhat in the form of a candle, with the two carbons as wicks. The same physicists have announced a further invention, which, in some sort, completes the first. A plate of kaolin is placed between the two extremities of the exterior wire of an induction coil, and that portion of it between the points is coated with a conducting substance. The current illuminates the latter, and gradually volatilises it; but, after its disappearance, the porcelain paste, heated to a red-white, is found to be conductive itself, and to give a good light. A luminous centre can thus be had quite as intense as with carbon points, but having the immense advantage of being absolutely steady. Further, with the same current, a number of these luminous centres can be formed. The authors have distributed the force of one coil among fifty burners on this new system, and they can vary the luminous intensity from the maximum of electric lamps to the brightness of a single candle. The invention appears to be one of great promise.

ACCORDING to Dr. Elliott Couls (in the *American Naturalist*) birds are killed by hundreds of thousands in the United States by perching on telegraph wires. We have always understood that, in order for a bird to receive a shock of electricity from a telegraph wire, it is necessary that it should form part of a circuit, which it would have some difficulty in doing, unless, indeed, it placed one leg on the wire and the other on the ground, in which case it would no doubt be terribly "shocked." Mr. Couls, however, it seems knows better, and does not seem to think that the injuries arise from the birds flying against the wires in the dusk or during foggy weather, which would be the natural conclusion. He counted, in one hour, a hundred birds killed. Their bodies lay under the wires. One bird, disabled, was seen fluttering along the road, and a second died in convulsions.

WITH a view to finding the cause of the peculiar zigzag form taken commonly by electric sparks, especially those of the Holtz machine, in air, Professor Tait, of Edinburgh, has recently had a number of photographs of such sparks prepared. These sparks were produced partly in ordinary air, partly in the free air one or two feet above the flame of a strong Bunsen burner, partly in a wide glass tube,

into which air was passed through a long iron tube, heated to a dark red glow. The general result of the examination is that the zigzag form depends on something which heat is capable of removing from the air. This is, therefore, not water vapour, nor is it very small drops of water, for even falling water drops were inactive, except that they produced simply an interruption in the photographed sparks. It is probably, the author thinks, organic substances, which, as Schiller and Pasteur have shown, would be kept away from the apparatus by a cotton stopper, as well as by direct combustion.

THE firm of Schuckert, in Nürnberg, have lately, we learn from *Ding. Pol. Jour.*, been devoting attention to the improvement of dynamo-electric machines, for galvanoplastic purposes and the electric light. Their machines are like the Gramme, but the following points may be noted: The rotating iron ring, wound with copper wire, is a flat disc; thus the wires of the two long sides of the cross section come under the action of the flap-shaped magnetic poles, and the induced currents of the two sides combine, having the same direction. The whole wire length is thus utilised. Centrifugal force at high velocity does no injury. Again, the iron ring is not in one massive piece, but in several ring discs, separated from each other by ebonite, pasteboard, or the like, the whole ring being held together by brass rivets. The object here is to hasten the disappearance of remanent magnetism, in rapid change of the poles, and to obtain the maximum of magnetisation. This construction allows of the fixing of the ring on metal without disturbing inductive action, since only a very small part of the wire is in contact with it, and the evil effects of a possible heating are obviated.

M. ONIMUS has lately observed that the suppuration of wounds or ulcers may, by means of continuous electric currents, be increased or diminished, according to the direction of the current. The descending current, that is, when the positive pole is placed near the nerve centre and the negative at the periphery, *increases* the suppuration, but, at the same time, the phenomena of nutrition are more considerable, and the fleshy pimples are formed with great rapidity. On the other hand, with the ascending current, the suppuration disappears very quickly. A small crust forms on the wound, which is difficult to remove, and under it there is a cicatrisation.

SOME measurements of the force of electro-diamagnetic induction currents have been recently made by MM. Töpler and Ettinghausen (*Pogg. Ann.*). The apparatus consisted of two large hollow coils, in which a mercury interrupter, of special form, admitted a regular series of currents. Within the coils were two other coils of fine wire connected by their contrary poles, arranged so that the induction currents entirely annulled each other. Into one of these a bismuth bar was introduced. For further particulars we must refer to the original.

City Notes.

Old Broad Street, April 30, 1877.

SATISFIED with his victory, Mr. Pender has been tolerably quiet during the past fortnight. It may be granted that if the three-shilling-a-word rate, which comes into force from the 1st May, could be permanently maintained, if it were absolutely impossible for any competitors to enter into the field—if, in short, things could always be ordered just as the gentlemen who are now the controlling spirits of the Anglo-American and Direct Companies desire—there would be no occasion for forebodings of any sort. The shares of the two companies would rise to such a degree that the hearts of the shareholders would be gladdened, and the wire-pullers, having endured the burden and heat of the day, might drink each other's health over the finest champagne procurable. But there are many who insinuate that Mr. Pender and his friends will not be permitted to enjoy their fool's Paradise for long. The public, it is said, might bear the two-shilling, but will kick at the three-shilling, rate; there will be perpetual murmurs on the part of disappointed shareholders, especially from those who were most willing to pin their faith to Mr. Pender's sleeve, and a combination which knows not, and will not know, the Globe Telegraph and Trust, will arise and make haste to take possession of the good things the gods once offered to the manager of the Direct Company. It was a bad day for the shareholders of the Direct when the "working arrangement" was concluded; but the end of their troubles is, we are afraid, not yet. Nor can we advise them to sell out, for our advice would be useless. No one in full possession of his senses is likely to buy shares in either the Anglo-American, the Direct, or the Globe (Heaven forbid!) for some time to come.

It is not surprising that Mr. Newton, speaking at the ordinary general meeting of the Eastern Extension Company, should have argued in favour of an amalgamation between the Eastern and the Eastern Extension Companies. Mr. Newton has been heard of before as a champion of amalgamation, though we have never been able to ascertain why he constitutes himself an authority on telegraphy. We believe he is better known in connection with the new Civil Service Stores in Queen Victoria Street. Yet he is no doubt correct in his averment that the amalgamation of the Eastern and Eastern Extension Companies would be "another great step towards the completion of the Globe Company's scheme." We happen, however, to think that the Globe Company's scheme deserves denunciation rather than praise; and even in spite of Mr. Abbott's support, we trust the shareholders of both the companies will, if they value their own interests, oppose Mr. Newton's proposition by every means in their power.

It is amusing to note that the chairman of the Eastern Extension Company—Mr. Pender himself—confessed, with evident reluctance, there were difficulties

in the way of amalgamation. He had also found "many objectors" to amalgamation—a fact we can readily believe. But his final utterance should have the effect of putting the shareholders on their guard. "He did not think it would be wise to urge this amalgamation *at present*"—the italics are ours. If we know anything of Mr. Pender—and we fancy we do—this simply means that Messrs. Newton and Abbott have made the mistake of advocating amalgamation before the shareholders have been educated up to it. When they have been sufficiently indoctrinated by Mr. Pender, then the chairman of the Eastern Extension Company will lend his influence to assist "the completion of the Globe Company's scheme." We shall do our best to prevent the progress of indoctrination. The Eastern Extension Company is admittedly none too prosperous as matters stand; we are confident that amalgamation, instead of increasing its dividends, would tend to diminish them. To Mr. Pender's platitudes about telegraph property we make no objection; all that he says concerning the importance of telegraphy we have said, and we have always had an abiding faith in the future development of telegraph undertakings. Nevertheless, they are more likely to succeed; not when they follow, but when they set at defiance, the counsel of financiers and stock-jobbers who, for purposes of their own, would be glad to see the Globe Trust Company fasten its claws upon all the telegraph companies which are *not* in "queer" street.

The re-constructed West India and Panama Company has, at least, the advantage of having friends who lose no opportunity of sounding its praises. Thus we were told a little time ago that difficulties deemed insurmountable had been overcome, "and the marked success which has attended the efforts of the very able board of directors of the company justifies the expectation of future prosperity, seeing that the interests of the company are in the keeping of successful administrators." We hope the career of the company may be all that the shareholders could wish, and we have a considerable amount of confidence in the gentlemen charged with the administration of its affairs. They are none of them novices in telegraphy. Nor is the interim account of the liquidators of the old company unsatisfactory. A net profit of £8,026 for the half-year ending December 31 is not bad. It will be admitted we are not put up to depreciate the shares of the company. But we have seen so many companies, with prospects brighter than the West India and Panama, come to grief, that we may perhaps be pardoned for not being so sanguine as the enthusiast who seems to think the holders of stock in this enterprise ought to be in the seventh heaven of delight. The meeting on the 2nd instant, like the report, is of course purely formal, and no importance therefore attaches to it. But we shall watch the career of the re-constructed company carefully, and none the less so because its legal rights are under the protection of Messrs. Bircham, who have given us a proof of their capacity to guard the interests of their clients.

The report of the Submarine Cables Trust, presented at the annual meeting to-day, is short, and by no means bitter. Perhaps some may think that, in the present aspect of affairs, £163,000 is a sum which might be invested more satisfactorily than in Anglo-American shares, particularly as only £146 is invested in Great Northern. But, in the main, we have little fault to find with the way in which the trustees have discharged their duties; the Pender influence has not in this case been overmastering.

We intend in future not to confine ourselves to telegraphs, and we commence to-day with a word or two about railways. Amalgamation may be undeniable in some cases, yet expedient in others. We have always held the opinion that union with the Great Northern Company would be the salvation of the Great Eastern. The Great Northern hardly requires to be saved; but we have the assurance of Mr. Jardine, himself a shareholder in both companies, that the fusion would promote the interests of the shareholders of both.

Judging from the tenor of the meeting last Wednesday, we may also conclude that the Great Eastern board is honestly anxious to bring about amalgamation. Even Sir E. W. Watkin, though guarding himself by the observation that "the prospective interests of the company must not be thrown away," hopes the negotiations may be brought to "a happy issue." May we assume from this that Mr. Bass's little idea of union with the Manchester, Sheffield, and Lincoln Company, as an alternative scheme, has been scattered to the winds? Has Sir E. W. Watkin finally abandoned the hope of becoming chairman of the Great Eastern and Manchester, Sheffield, and Lincoln United? It is possible we have omitted to give Mr. Bass credit for the virtues he possesses. We can understand that a fusion between the Great Eastern and Manchester, Sheffield, and Lincoln would not increase the charges incident to the transmission of beer; and if Mr. Bass has determined to support the policy advocated by Mr. Kimber, his self-denial will not be forgotten. Sir E. W. Watkin may eventually sit in the seat he covets. The union of the Great Eastern and Great Northern will, it is affirmed, be distinctly to the advantage of the public. There is room for improvement, so far as the public is concerned, on the Great Eastern lines. But it may be reasonably wished that some benefit may also accrue to the shareholders. At least, it may then be possible to arrive at the real value of Great Eastern stock. Just now that is a puzzle which seems incapable of solution.

Proceedings of Societies.

THE SOCIETY OF TELEGRAPH ENGINEERS.

A PAPER on "Quadruplex Telegraphy," by Mr. G. B. Prescott, electrician of the Western Union Telegraph Company, New York, was read before the Society at its meeting, held on April 11.

It will be unnecessary for us to enter into the mechanical and electrical details of a system whose principles have already been described in the pages of this journal. Suffice it to say that it has remained almost unaltered, with the exception of the transmitting reversal arrangement and the receiving non-polarised relay, which have undergone such mechanical modifications as theory and practice united have been suffered to dictate.

The system, as described in journal No. 70, Jan. 1, 1876, is a combination of the closed circuit, multiple-transmission, and duplex systems. For lines of considerable length the bridge duplex is almost universally employed. In that portion of the connections technically known as the bridge-wire, two relays are, as a rule, situated, the one polarised, the other possessing a soft iron armature. Two transmitting keys are placed at each end of the line, and upon them devolve the duties of regulating the strength and polarity of the current flowing from the station. When both keys are open, a current of constant strength traverses the line. When the one is depressed, a current of three or four times the normal strength passes through the

apparatus at the distant station, the polarised relay remains unaffected by the change, but the current in the other, before too weak to attract its armature, now attains sufficient intensity to close the local circuit. The elevation or depression of this key simply determines the strength of the current flowing through the line, independent of its polarity, while the case is reversed with the second key, which, when closed and opened, reverses and restores to its normal condition the polarity of the current without reference to its strength. It will hence be seen that the relays at the distant station respond only to the manipulation of their respective keys, and since the entire set is duplexed simultaneous transmission of two messages in opposite directions immediately becomes possible.

An important feature in the extension of this system, and one which is said to have greatly enhanced its value to the company employing it, is the combination of duplex and quadruplex transmissions which can be effected. For example: the line, 550 miles in length, extends from Boston to Buffalo; translating at Albany 350 miles from the latter town. The line is worked as follows: Boston sends to Buffalo, Buffalo to Boston; Boston to Albany, and Albany to Boston; Buffalo to Albany, and Albany to Buffalo. Although this statement may, at first sight, appear in every way a very complex one, yet a moment's consideration of the advantages of quadruplex working, combining, as we have already stated, the qualities of the duplex and multiple systems, will, we think, render its truth and feasibility apparent. To begin with, Boston and Buffalo could, it is clear, send two messages in opposite directions to each other at the same time, and Albany, being the intermediate translating station, could also, if necessary, receive the four despatches, but, by some means not mentioned on the paper, only one such message in each direction, or two messages in all, are permitted to be translated on to the opposite terminal stations. Thus Boston can send to and receive from Buffalo one message at the same time. Supposing these to be received on the polarised relays, they alone can translate at Albany; the non-polarised relays do not possess this property, and the line is pratically broken up to all despatches so received. Thus Albany can receive from both Buffalo and Boston, and by properly arranging the connections Albany can, at the same time, send to each. If these facts be borne in mind we find that on each section of the line two messages are sent in the opposite directions at the same time, and for these, as we have seen, a system of quadruplex telegraphy theoretically provides. Several circuits are arranged in this manner, and other combinations of the two above-mentioned systems can, when necessary, be effected.

A communication was then read upon the duplex system in operation upon the Marseilles-Algiers cable.

This cable is 445 miles in length. The system employed is the ordinary bridge duplex, and the receiving instrument is the mirror galvanometer. This galvanometer is provided with two coils, not necessarily, though perhaps preferably, of equal magnetic effect. One is situated in the bridge-wire, and the other in a condenser circuit of 20 microfarads capacity, one terminal of which is connected with the bridge-wire, and the other to earth through the galvanometer coil. The advantage claimed for this arrangement is a saving of condenser power, for that coil in the condenser circuit not being shunted by the arms of the bridge, as is that situated in the bridge-wire, less discharge is necessary to neutralise the effect of the discharge set up in the cable when sending. Eight cells are used to work the cable, and the reading, when working duplex, is, we are told, if anything, better than when working singly.

The President then invited discussion upon the papers that had been read.

Mr. Kempe remarked that the question with which telegraph engineers had to deal was not whether it were possible to establish quadruplex telegraphy, for that had long since been answered in the affirmative, but rather whether such a system would prove commercially successful, that is to say, would the speed at which such apparatus or sets of apparatus could be worked justify the necessary expense of extra battery-power, resistance-coils, &c., in place of erecting a second line, and employing the duplex system on both. He showed that in the absence of any statistics of speed in Mr. Prescott's paper the arguments tended in favour of the latter course of proceeding.

Mr. J. Muirhead, jun., mentioned that he had witnessed the working of the Marseilles-Algiers cable, and could corroborate the statements made in the communication. The cable, he remarked, was an easy one to duplex, the length and retardation not being very great, the latter owing to one or two slight faults in its insulation. After mentioning one or two additional arguments in favour of the facility for duplexing the cable, Mr. Muirhead expressed his inability to go further into the matter, pending the result of legal proceedings which had been taken against the French Government on his behalf for infringing his patent.

Mr. Preece stated that it was a mistake to suppose that no attempts had been made in England and other countries besides America to establish duplex and quadruplex telegraphy upon a firm footing. He, at an early date, among many others, plunged into the subject as soon as the question of its feasibility had been extended, and he invented an experimental system of duplex telegraphy at that time, which was eventually in action between Cowes and Southampton. It was then known as the leakage principle. A limit was, however, soon prescribed to the length of line over which duplex telegraphy could be successfully introduced, due partly to the defective insulation at that time, and partly to static induction; it was not until Mr. Muirhead, in England, and Mr. Stearns, in America, had introduced the condenser to compensate the discharge from the line that duplex working assumed the important feature which it now holds in the present day.

In the Postal Telegraph Department of England a large number of circuits are worked on the duplex principle.

Glowing accounts have reached us from time to time of the working of the different telegraph systems in America, and it was with a view to ascertaining the relative value of these systems as compared with the working of those in England that the Government was sending officers to America. As one of those officers, he was on the eve of departure, and he entertained the hope of communicating his observations of this system to the Society on his return.

Mr. R. von Fischer Treuenfeld expressed his opinion that the first successful attempt at duplex telegraphy was in May, 1854, between Hanover and Göttingen, in Germany, and that the general idea that duplex telegraphy only became practicable after the Stearns and Muirhead's patents came into effect was an erroneous one. Dr. C. W. Siemens patented the system in England in November, 1854, and in that and the two succeeding years Messrs. Siemens and Halske fitted out no less than ninety stations in different parts of the world with sets of duplex apparatus. The urgency for its adoption, however, did not then exist, and the system, from its comparative cost and complication, fell out of use.

Mr. Faulkner made several statements relating to the introduction of duplex telegraphy, and mentioned that, in his opinion, the system was not banished from the field of competition owing to its want of efficiency, but to the prejudice of the telegraph companies then in existence.

Mr. Faulkner then explained and exhibited some new forms of sounders, based on the Altandae system, and of which he spoke in the highest terms, when, after votes of thanks had been passed, on the motion of the President, to the authors, the meeting was adjourned.

PHYSICAL SOCIETY—14TH APRIL, 1877.

Prof. G. C. FOSTER, President, in the chair.

THE SECRETARY described a new form of calorimeter devised by Dr. Mills. It consists of two vertical glass tubes about ten centimetres in length and two centimetres in diameter, and contracted at their lower ends, which are graduated in millimetres and fixed in a frame. In each tube a loosely fitting disc of white or black glass (as occasion may require) can be raised or lowered from below by means of a glass rod, and the concave meniscus of the liquid is concealed from view by a wooden screen. The two liquids under examination are introduced into the tubes to the same level, and the discs adjusted until rendered invisible.

Mr. CHRISTIE gave an account of a new form of spectroscope, in which "half-prisms" are used to magnify the dispersion. He pointed out that the angle between two pencils is magnified by the action of a half-prism, and in consequence of this, a half-prism will give great dispersion or great purity, according as the rays from the slit fall first on the perpendicular or oblique face; and it may be advantageously used in preference to the ordinary isosceles prism, and adapted to the special circumstances of an experiment. Incidentally Mr. Christie explained that the condition of minimum deviation was rendered unnecessary by the introduction of the collimator, which makes the rays parallel before falling on the prisms, and with a half-prism there is the great advantage that different parts of the spectrum can be brought into the field by simply turning the prism about its centre. The case of a compound prism was then considered; and Mr. Christie mentioned that with a direct-vision half-prism a dispersion equivalent to that of ten ordinary prisms had been obtained without any loss of definition. Such prisms can be combined in trains, magnifying or diminishing according as great dispersion or purity is required. From the nature of the case great dispersion must always be accompanied by loss of light. Most spectroscopes would give a much brighter spectrum if they had smaller prisms, but a high magnifying power could not then be applied. In the half-prism spectroscope, though the thickness of glass is far less, yet, as it should not exceed a total of five or six inches, there would be advantage in using composite prisms, exactly similar, and cemented side by side. Mr. Hilgar has actually made a double prism on this plan, which seems to answer perfectly. In illustration of these principles Mr. Christie exhibited three spectroscopes recently made by Mr. Hilgar, in which a wide separation of the sodium lines was obtained by means of two half-prisms (direct-vision), and explained some details of construction. He also showed that by reversing such a train of half-prisms very great purity is obtained, so that the sodium lines are seen in the light of an ordinary unsalted candle without the use of collimating lenses; and he mentioned that he had, in the same way, seen the Fraunhofer lines in the sun and moon.

Dr. HUGGINS called special attention to the convenience and portability of this form of spectroscope, as well as the great advantage of only employing two or three inches of glass; and he expressed himself as very favourably impressed with the few small instruments he had had an opportunity of examining.

IT is with pleasure we learn from America that the sale of Mr. Prescott's admirable work, "Electricity and the Electric Telegraph," is so rapid that a second edition will at once be put to press.

Correspondence.

We extract the following from the April 2nd number of the New York JOURNAL OF THE TELEGRAPH:—

THE USE OF MAGNETO-ELECTRIC CURRENTS FOR TELEGRAPHIC PURPOSES.

JERSEY CITY, N. J., *March* 13.

To the Editor of the *Journal of the Telegraph*.

IN the *Journal of the Telegraph* for February 15th is copied from the *Telegraphic Journal* of London a short *résumé* of experiments made with magneto-electric machines and currents for telegraphic purposes in England and America. As the machines used in this country for that purpose were made according to my patent, dated September 21, 1875, I have read with great interest the brief article referred to in regard to the results obtained.

My magneto-electric machines have been successfully employed for electro-plating and electric lights, and with the material at hand I am sure a machine can be constructed adapted to telegraphic purposes in every respect. The difficulties mentioned in the article referred to are not, in my opinion, of such a character that they cannot be overcome, and the whole matter, it seems to me, is a want of theoretical and practical knowledge and skill, and the problem one that will soon be solved, when telegraph companies earnestly desire to use handsome and portable machines instead of large and cumbersome batteries for generating electric currents.

The editor of the *Telegraphic Journal* says: "Experiments have been made in England with Wyld's and Gramme's machines, but not with such success as to justify their practical adoption. The objection was principally one of expense. The currents produced were, however, the reverse to those obtained in America; the quantity was very great and the tension low."

The editor of the *Telegraphic Journal* seems to overlook the fact, known and understood by every electrician, that the more or less quantitative, or more or less intense current produced by a magneto-electric machine is due to the mode of constructing the machine, and not to the principles involved.

The editor of the *Telegraphic Journal* further says: "The immense advantage of a battery consists in the power it gives the engineer to suit his currents to his circuits. No magneto-electric machine can do this." I wish to ask the editor why a magneto-electric machine cannot be built to suit the circuits? Or does he mean that the machine current is so uniform and constant that it cannot be varied?

The current produced by my magneto-electric machines is due to the rise and fall of magnetism induced in a range of armature cores that are revolved contiguous to stationary magnets, and the current produced is proportionate to the amount of magnetism induced in the armature cores; and the number of revolutions of the revolving armature. The one as well as the other of these factors can be varied. The magnets can be made adjustable, and the current regulated at the will of the operator, as I have shown in my patent, dated September 29, 1874. I contemplate at some future time taking up this subject, and giving some details about constructing machines for telegraphic purposes.

Inclosed I send you a copy of my patent, dated November 14, 1876, relating to improvements on the above-mentioned patent, whereby I obtained in the machines that were used for illumination of the Western Union building, July 3, 1876, about 100 per cent. more current than had before been obtained. I also inclose a drawing illustrating different forms of my magneto-electric machine,

OTTO HEIKEL.

[In reply to these queries we beg to refer Mr. Heikel to our leading article.—ED. TEL. JOUR.]